

# **"Terry Fest"**

**A Symposium on the Structure of the Nucleon  
Lancaster, April 2003**

**John Womersley**

**Fermi National Accelerator Laboratory, Batavia, Illinois**

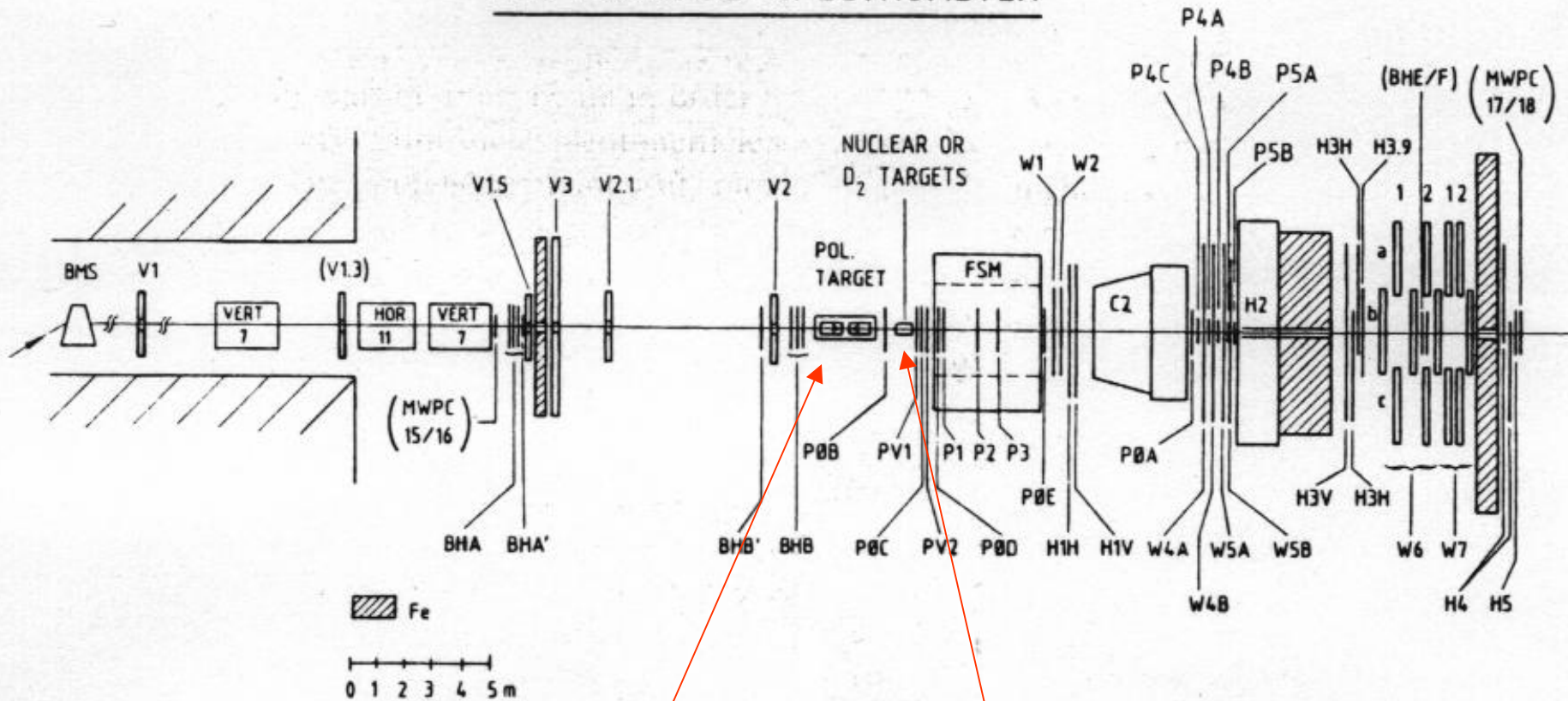


# Terry and me

- I was an Oxford University graduate student on the EMC experiment from 1983 to 1986 and spent two years at CERN
  - I worked on the small high rate proportional chambers (“P0 chambers”) used to provide tracking coverage close to the beam
  - The wire planes for these chambers were wound at Lancaster
- At this time the NA9 vertex magnet and the streamer chamber had been removed (along with Hugh Montgomery) and were being sent to Fermilab
- EMC was taking data with the polarized target and nuclear targets (experiments NA2’ and NA28)
- Terry was spokesman of the experiment for this whole period



# EMC FORWARD SPECTROMETER



**Polarised Target**

**Nuclear Targets**





# bulletin



SEMAINE DU LUNDI 26 AOUT

n° 35/85

WEEK MONDAY 26 AUGUST



John L'EMC extrait la dernière bande.

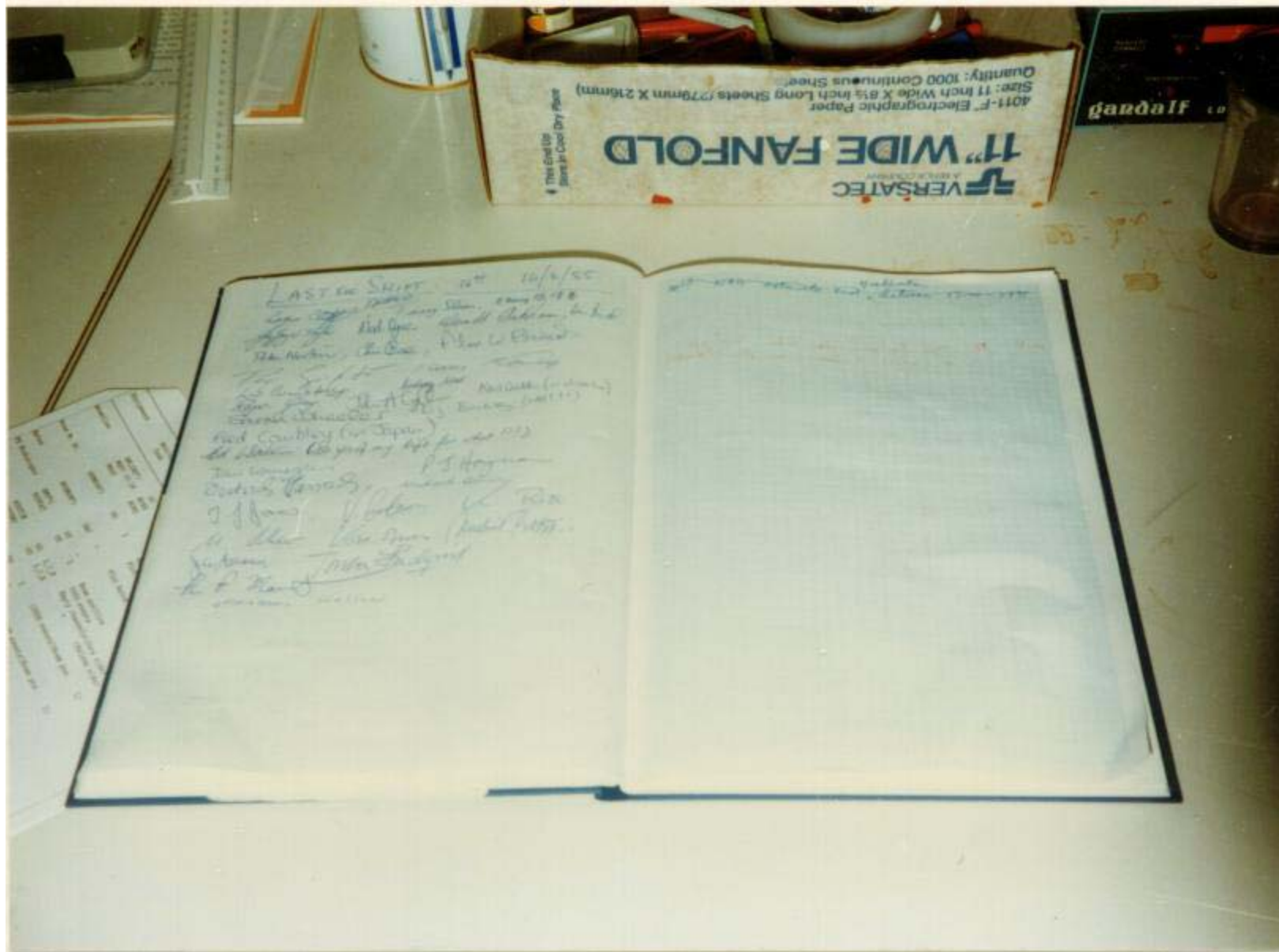
EMC dismount the last tape.





*John Womersley*





# Physics Impact

- EMC was an enormously influential and productive experiment
- Consider the following SPIRES query
  - **FIND CN D0 AND TOPCITE 500+**
    - Returns 1 paper (“observation of the top quark”)
    - An additional 3 papers with > 100 citations

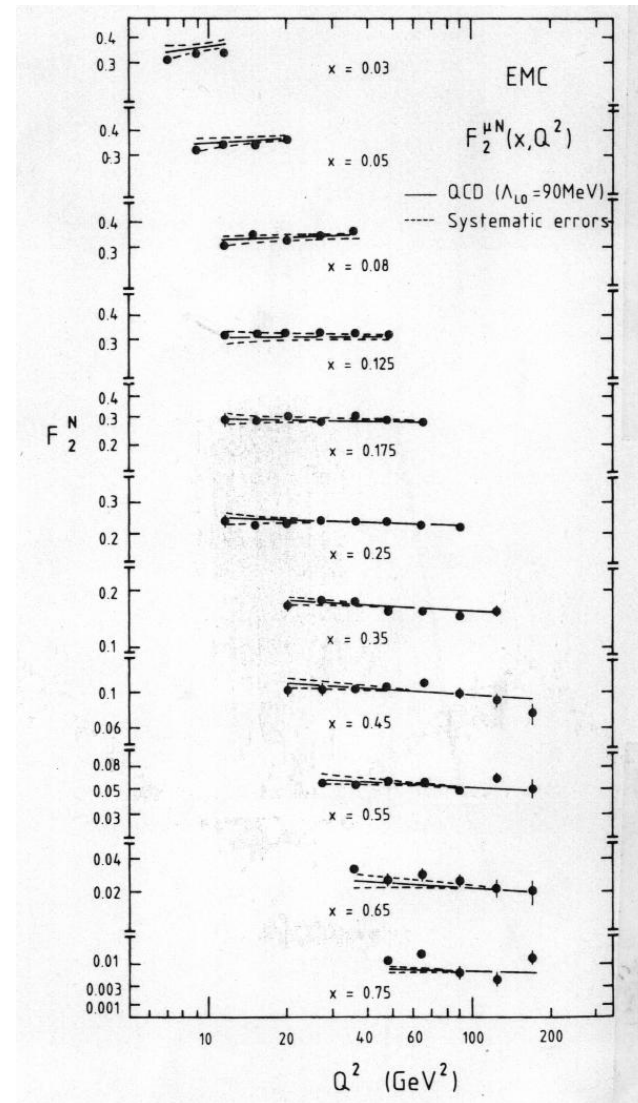
compared with

- **FIND CN EUROPEAN MUON COLLABORATION AND TOPCITE 500+**
  - Returns 3 papers
  - An additional 7 papers with > 100 citations
  - An additional 17 papers with > 50 citations



# Structure Functions

- Precise measurements of structure functions and their  $Q^2$  dependence using hydrogen, deuterium and heavy targets
- Comparisons with QCD
  - Precise determination of parton distributions remains a critical ingredient in hadron collider physics (Tevatron, LHC)

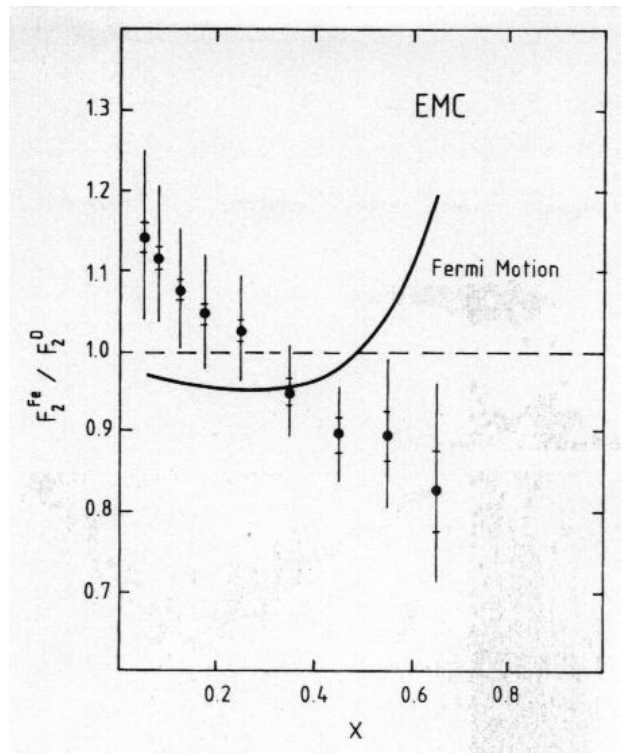




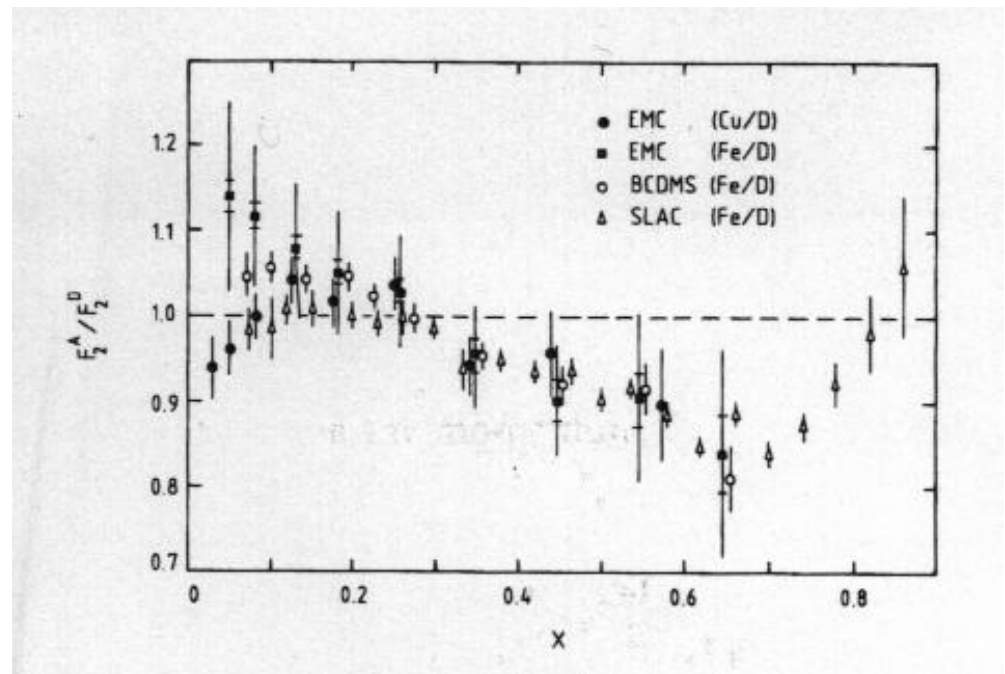
# The EMC effect

- The parton distributions of nucleons in heavy nuclei are not the same as those of bare nucleons

## First indications

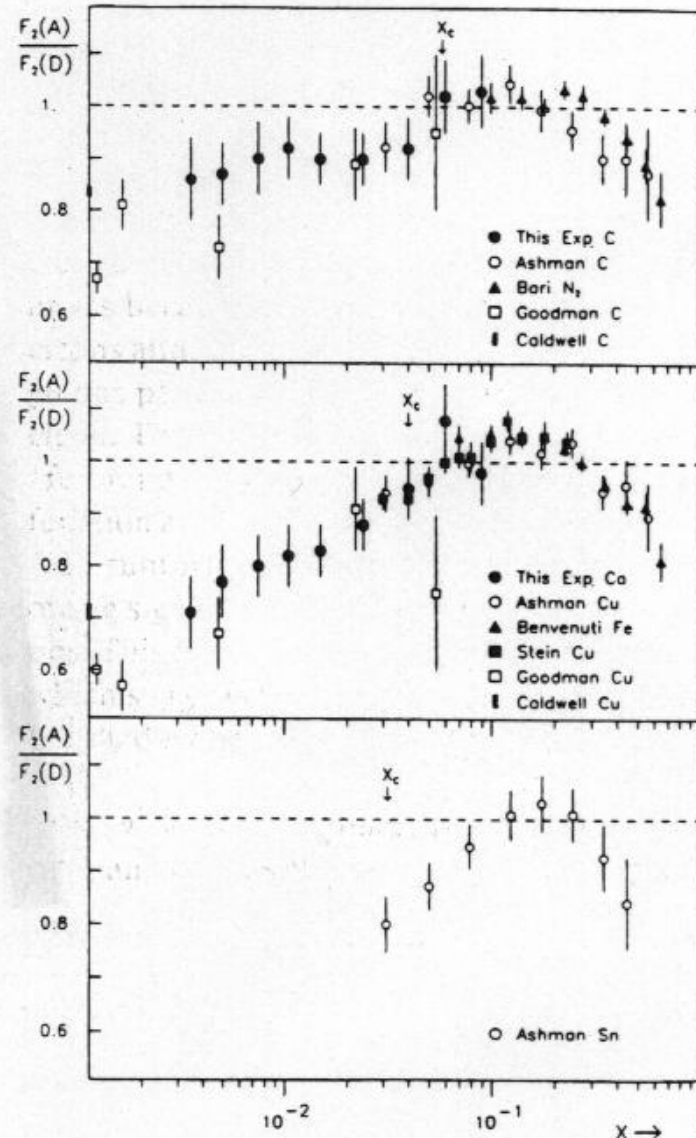


## More detailed investigation

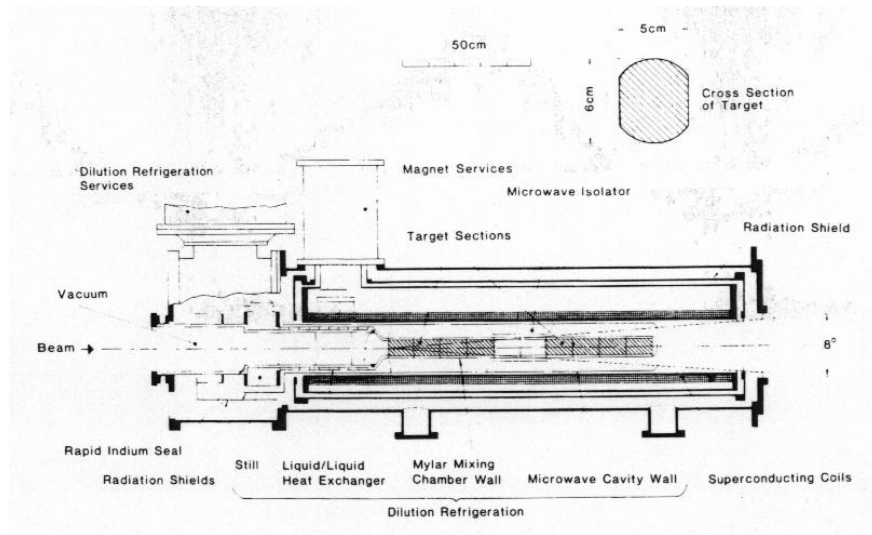


# Shadowing

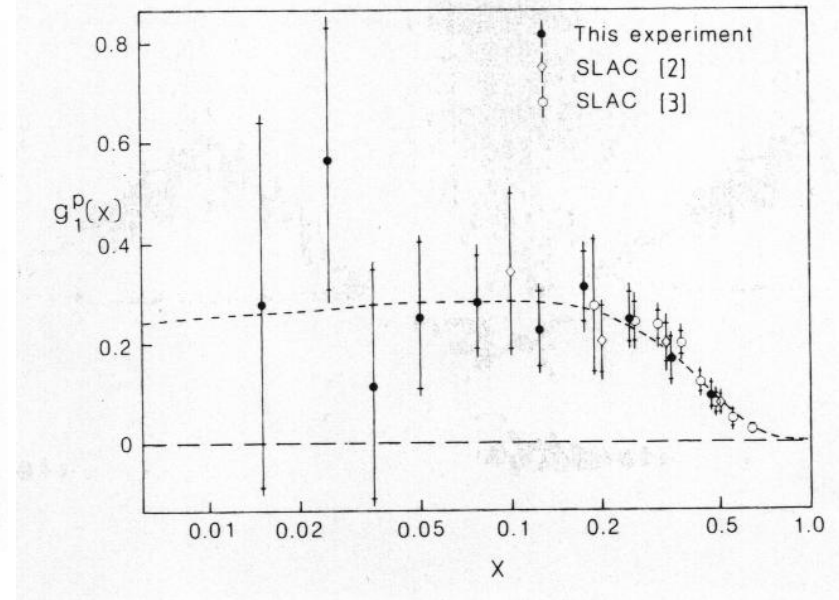
- Extend these  $F_2$  ratio measurements to very low  $x$



# Spin Structure of the Proton



**Polarised ammonia target**



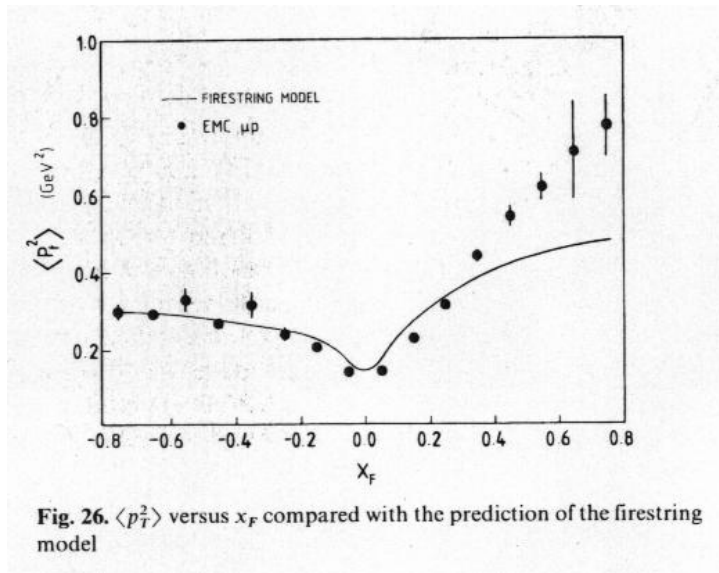
**Spin-dependent structure function  $g_1(x)$**

- **Striking disagreement with the Ellis-Jaffe sum rule**
  - **Only  $(12 \pm 9 \pm 14)\%$  of the spin of the proton is carried by quarks**

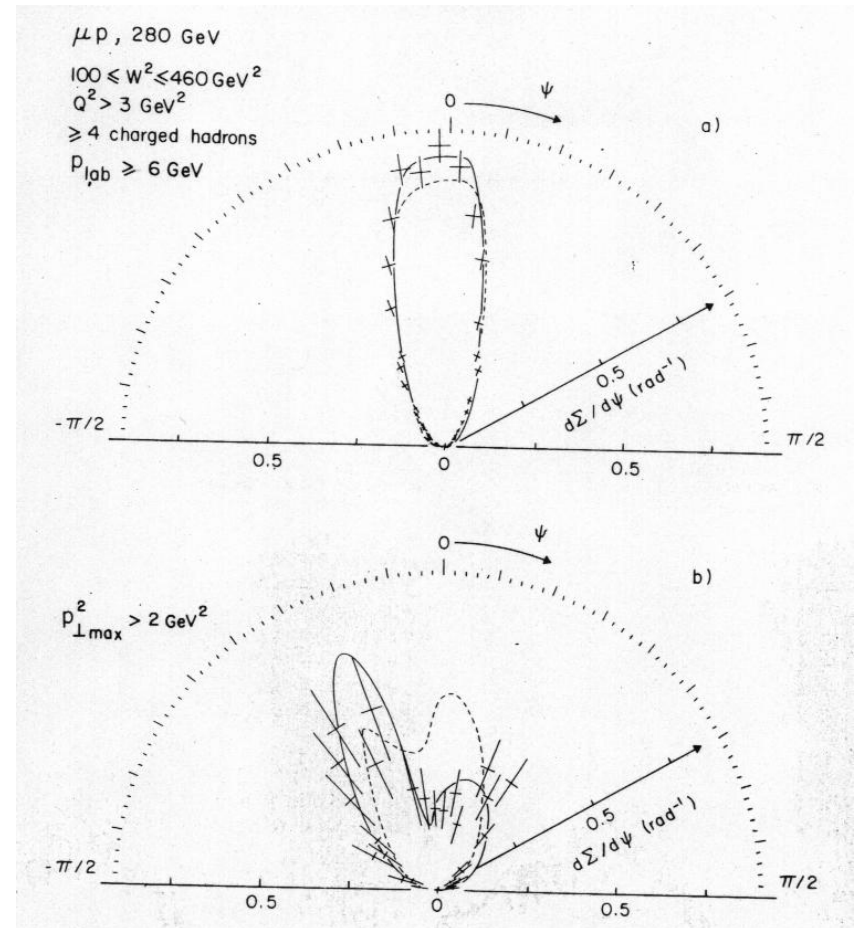


# QCD

- Jet production and fragmentation



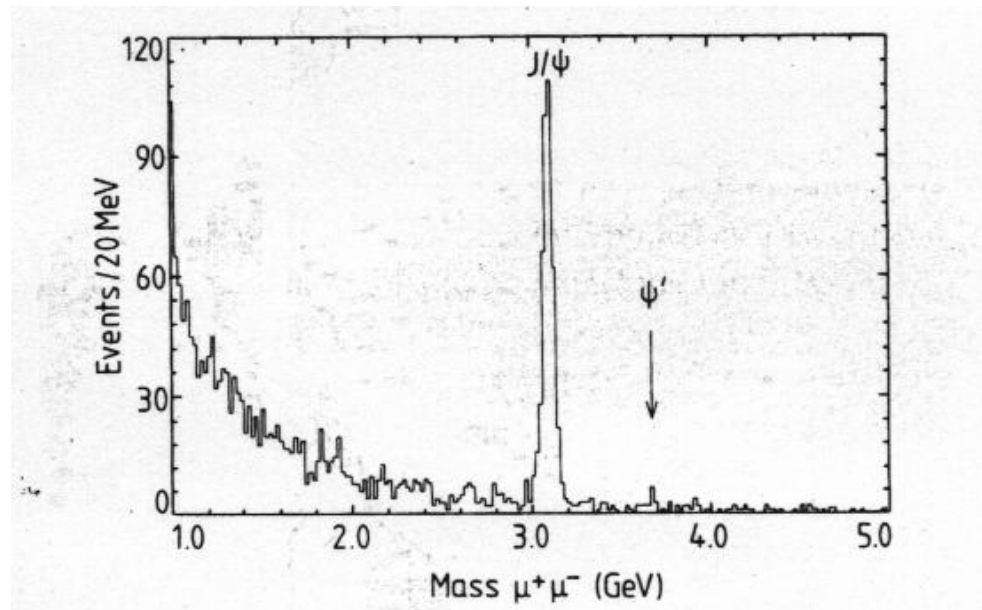
**"Seagull plot"**



**Observation of forward two-jet structure**



# Heavy flavour production



- Measured cross sections for  $J/\psi$  and open charm production
- “Ideal testing ground for hard QCD processes”...
  - If only!
  - Charmonium production in hadron collisions is still hard (impossible?) to calculate reliably in perturbative QCD...





# Summary of the Physics Impact

- **Precision measurement of structure functions**
  - Precise determination of parton distributions remains a critical ingredient in hadron collider physics (Tevatron, LHC)
- **Quark parton model → perturbative QCD**
  - Laid the foundations for high  $p_T$  jets at HERA and the Tevatron
  - Heavy flavour production (still a challenge to predict)
  - Jet Fragmentation (PYTHIA, HERWIG were being developed)
- **Nuclear effects**
  - Beyond  $A^{1/3}$
  - Interface of particle and nuclear physics
  - Opened the door to a whole new field (CEBAF...)
- **Origin of Nucleon spin**
  - Again, opened the door to a whole series of experiments (which are still ongoing)
  - remains mysterious...



# There's more to life than physics ...

- **Some of my memories of this time**
  - Ronald Reagan and Mikhail Gorbachev
  - Margaret Thatcher and Arthur Scargill
  - The Kendrew Report
  - Boy George
  - Carlo Rubbia
  - “the CERNabend processor has control”
  - Learning to ski
  - Learning to ski with a really bad hangover





*John Womersley*



**PISSED UP**

An invitation to further indiscretions

**FOR YOU**

Number 7, 8th December 1984

**THIS WEEK**

INTERNATIONAL JOURNAL OF HIGH ENERGY PHYSICS

'These are not really cuts in grants. They are merely reductions in promised additions.' - Sir Keith Joseph, 5.12.84



**christmas special issue**

John Womersley





# EMC End-of-Run Barbecue 16/8/85







*John Womersley*





*John Womersley*





# EMC Main Meeting, Balatonaliga, Hungary, September 1985





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*John Womersley*





# Terry's contribution

- Under Terry's leadership, EMC provided a
  - Welcoming
  - Collegial
  - Productive
  - Helpful
  - Exciting
  - Funenvironment in which to learn particle physics
- I now know that these things don't just happen by chance, but the leadership of the experiment sets the tone in myriad small ways:



